# Mercury Content of Soil, Lake Sediment, Net Plankton, Vegetation, and Forage Fish in the Area of the Churchill River Diversion, Manitoba, 1981-82

R.A. Bodaly, N.E. Strange, R.E. Hecky,
R.J.P. Fudge and C. Anema

Central and Arctic Region
Department of Fisheries and Oceans
Winnipeg, MB R3T 2N6

March 1987

**Canadian Data Report of Fisheries and Aquatic Sciences No. 610**

87-02032/

## Canadian Data Report of Fisheries and Aquatic Sciences

Data reports provide a medium for filing and archiving data compilations where little or no analysis is included. Such compilations commonly will have been prepared in support of other journal publications or reports. The subject matter of data reports reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Data reports are not intended for general distribution and the contents must not be referred to in other publications without prior written authorization from the issuing establishment. The correct citation appears above the abstract of each report. Data reports are abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1–25 in this series were issued as Fisheries and Marine Service Data Records. Numbers 26–160 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Data Reports. The current series name was introduced with the publication of report number 161.

Data reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

## Rapport statistique canadien des sciences halieutiques et aquatiques

Les rapports statistiques servent à classer et à archiver les compilations de données pour lesquelles il y a peu ou point d'analyse. Ces compilations auront d'ordinaire été préparées à l'appui d'autres publications ou rapports. Les sujets des rapports statistiques reflètent la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports statistiques ne sont pas destinés à une vaste distribution et leur contenu ne doit pas être mentionné dans une publication sans autorisation écrite préalable de l'établissement auteur. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports statistiques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 25 de cette série ont été publiés à titre de relevés statistiques, Services des pêches et de la mer. Les numéros 26 à 160 ont été publiés à titre de rapports statistiques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 161.

Les rapports statistiques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Data Report of
Fisheries and Aquatic Sciences 610

March 1987

# MERCURY CONTENT OF SOIL, LAKE SEDIMENT, NET PLANKTON, VEGETATION, AND FORAGE FISH IN THE AREA OF THE CHURCHILL RIVER DIVERSION, MANITOBA, 1981-82

by

R.A. Bodaly, N.E. Strange, R.E. Hecky,
R.J.P. Fudge and C. Anema

Central and Arctic Region
Department of Fisheries and Oceans
Winnipeg, Manitoba R3T 2N6

This is the 3rd Data Report
from the Central and Arctic Region, Winnipeg

© Minister of Supply and Services Canada 1987

Cat. no. Fs 97-13/610E ISSN 0706-6465

Correct citation for this publication is:

Bodaly, R.A., N.E. Strange, R.E. Hecky, R.J.P. Fudge, and C. Anema. 1987. Mercury content of soil, lake sediment, net plankton, vegetation, and forage fish in the area of the Churchill River diversion, Manitoba, 1981-82. Can. Data Rep. Fish. Aquat. Sci. 610: iv + 33 p.

TABLE OF CONTENTS


| | Page |
|---|---|
| ABSTRACT/RÉSUMÉ | 1 |
| INTRODUCTION | 1 |
| MATERIALS AND METHODS | 1 |
| Study sites | 1 |
| Soil and vegetation sampling | 1 |
| Fish sampling | 2 |
| Limnological sampling | 2 |
| Field sampling | 3 |
| Laboratory analyses | 3 |
| ACKNOWLEDGMENTS | 3 |
| REFERENCES | 3 |
| FIG. 1. Map of study area showing sample sites | 33 |


LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1 | Concentration of total mercury in upper 2 cm of unflooded soil from 13 sites in the area of the Churchill River diversion, 1981 | 5 |
| 2 | Concentration of total mercury in unflooded soil horizons from 13 sites in the area of the Churchill River diversion, 1981 | 6 |
| 3 | Concentration of total mercury in unflooded soil horizons from 7 sites in the area of the Churchill River diversion, 1982 | 7 |
| 4 | Concentration of total mercury in sediment samples from 13 sites in the area of the Churchill River diversion, 1981 | 8 |
| 5 | Concentration of total mercury in flooded soil horizons from 11 sites in the area of the Churchill River diversion, 1981 | 9 |
| 6 | Concentration of total mercury in flooded soil horizons from five sites in the area of the Churchill River diversion, 1982 | 10 |
| 7 | Mercury, carbon, phosphorus, and nitrogen content of unflooded vegetation from Wupaw Bay, Southern Indian Lake, 1976 | 11 |
| 8 | Concentration of total mercury in spottail shiner muscle from 12 sites in the area of the Churchill River diversion, 1981 | 16 |
| 9 | Concentration of total mercury in yellow perch muscle from 7 sites in the area of the Churchill River diversion, 1981 | 17 |
| 10 | Concentration of total mercury in spottail shiner muscle from 10 sites in the area of the Churchill River diversion, 1982 | 18 |
| 11 | Concentration of total mercury in yellow perch muscle for samples taken from 7 sites in the area of the Churchill River diversion, 1982 | 19 |
| 12 | Major dissolved constituents at 1981 sampling sites; Na, K, Ca, Mg, Cl, $SO_4$, dissolved inorganic carbon (DIC), pH and specific conductance (COND) at 13 sites in the area of the Churchill River diversion, 1981 | 20 |
| 13 | Dissolved and suspended constituents at 1981 sampling sites; Fe, Mn, total dissolved nitrogen (TDN), total dissolved phosphorous (TDP), $NH_4$, dissolved organic carbon (DOC), suspended nitrogen (SN), suspended phosphorous (SP) and chlorophyll-a (Chl-a) at 13 sites in the area of the Churchill River diversion, 1981 | 23 |
| 14 | Other limnological variables at 1981 sampling sites; total suspended solids (TSS), temperature (TEMP), daily primary production of carbon (PROD), molecular oxygen concentration ($O_2$ CONC), relative saturation ($O_2$ SAT) and oxygen consumption in the water column ($O_2$ RESP), and absorbances at 455 nm after centrifugation and at 453 nm before filtration (UNFILT), after filtration (FILT), and after centrifugation (CENT) at 13 sites in the area of the Churchill River diversion, 1981 | 26 |
| 15 | Concentration of total mercury in various netplankton size fractions from 13 sites in the area of the Churchill River diversion, 1981 | 29 |
| 16 | Correlation coefficients between the mean concentrations of total mercury in yellow perch muscle and spottail shiner muscle and the concentration of total mercury of the upper 2 cm of unflooded soil, of the upper horizons of unflooded soil, and of the sediment, the apparent depletion of total mercury in soil horizons, the means of various limnological parameters, and the means of concentrations of total mercury in various net plankton size fractions for 13 sites in the area of the Churchill River diversion, 1981 | 30 |
| 17 | Correlation coefficients between the mean concentrations of total mercury in yellow perch muscle and spottail shiner muscle and the values for various limnological parameters and the concentration of total mercury in various net plankton size fractions for 13 sites in the area of the Churchill River diversion, 1981 | 31 |
| 18 | Correlation coefficients between the mean concentrations of total mercury in yellow perch muscle and spottail shiner muscle and the concentration of total mercury in upper soil horizons of unflooded soil, and the apparent depletion of total mercury in upper soil horizons for seven sites in the area of the Churchill River diversion, 1982 | 32 |

## ABSTRACT

Bodaly, R.A., N.E. Strange, R.E. Hecky, R.J.P. Fudge, and C. Anema. 1987. Mercury content of soil, vegetation, lake sediment, net plankton and forage fish in the area of the Churchill River diversion, Manitoba, 1981-82. Can. Data Rep. Fish. Aquat. Sci. 610: iv + 33 p.

This study was undertaken to determine possible relationships between background (soil, sediment and vegetation) mercury concentrations, forage fish mercury levels, the amount of depletion of mercury in flooded soil and associated limnological parameters at various sites on and near the Churchill River diversion, northern Manitoba. In 1981, 13 sites (11 flooded, 2 unflooded) were sampled for sediment, flooded and unflooded soil, populations of small fish and limnological parameters. In 1982, seven sites (five flooded, two unflooded) were sampled for flooded and unflooded soil and populations of small fish. This report presents data for the mercury concentrations in these samples and some correlation coefficients between various quantities.

Key words: mercury; reservoirs (water); flooding; soils; moss; vegetation; sediments; spottail shiner; limnology; pH; chlorophyll; temperature (water); primary productivity; oxygen; dissolved ions.

## RÉSUMÉ

Bodaly, R.A., N.E. Strange, R.E. Hecky, R.J.P. Fudge, and C. Anema. 1987. Mercury content of soil, vegetation, lake sediment, net plankton and forage fish in the area of the Churchill River diversion, Manitoba, 1981-82. Can. Data Rep. Fish. Aquat. Sci. 610: iv + 33 p.

Cette étude a été entreprise en vue de déterminer les rapports qui pourraient exister entre les concentrations de mercure de fond (sol, sédiment et végétation) le niveau de mercure dans le poisson alimentaire, la quantité de mercure que libèrent les sols inondés et les paramètres limnologiques s'y rapportant à divers endroits dans le nouveau cours du Churchill, dans le nord du Manitoba, et dans se environs immédiats. En 1981, il y a eu dans 13 lieux (11 inondés et 2 non inondés) prélèvement de sédiments, de terre dans des endroits inondés et non inondés, de sujets parmi les populations de petits poissons et contrôle des paramètres limnologiques. En 1982, il y a eu prélèvement d'échantillons de terredans des endroits inondés et non inondés ainsi que de sujets parmi les population de petits poissons dans sept lieux (5 inondés et 2 non inondés). Ce rapport présente les données sur les concentrations de mercure dans ces échantillons et des coefficients de corrélation entre diverses valeurs.

Mots-clés: mercure; réservoirs (d'eau); inondation; sols; mousse; végétation; sédiments; queue à tache noire; limnologie; pH; chlorophylle; température de l'eau; productivité primaire; oxygène; ions dissous.

## INTRODUCTION

High levels of mercury in commercially important fish species were first noted in lakes flooded by the Churchill River hydroelectric project in northern Manitoba in late 1978. It was later demonstrated, for two of the lakes flooded for which both pre- and postimpoundment fish mercury data were available, that mercury levels in fish had risen coincidentally with flooding (Bodaly and Hecky 1979). The link between recently impounded reservoirs and high mercury levels in fish has recently been made in many areas (Abernathy and Cumbie 1977; Bruce and Spencer 1979; Cox et al. 1979; Potter et al. 1975; Waite et al. 1980; Lodenius et al. 1983).

An apparent relationship between the proportion of new reservoir surface area to flooded area and fish mercury levels was noted for lakes in the area of the Churchill River diversion by Bodaly et al. (1984a). This observation lead to the hypothesis that high mercury levels in fish in new reservoirs were due to the bacterial methylation of naturally occurring mercury found in flooded soils (Bodaly et al. 1984a). Cox et al. (1979) demonstrated an apparent depletion of soil mercury coincidentally with declining mercury levels in fish in an Illinois impoundment, implying that the amount of mercury available in flooded soils in reservoirs may be an important factor in determining mercury levels in fish. Abernathy and Cumbie (1977), while noting that flooded soils do provide an increased source of mercury to new reservoirs, hypothesized that declines in mercury levels in fish as reservoirs age may be related to the trophic state of the reservoir.

It is the purpose of this report to present data on mercury concentrations in forage fish, sediment, flooded and unflooded soil, vegetation, and netplankton, and to present data concerning limnological measurements which were made in conjunction with sampling for mercury content. Sampling was conducted over the course of two years at a number of sites in the area of the Churchill River diversion in northern Manitoba. Two of the sampled sites were unflooded, while the remainder were all on flooded lakes. The sampling was conducted to test the following hypotheses: first, that mercury concentrations in small fish in flooded areas was elevated relative to unflooded areas; second, that soil mercury was demonstrably depleted in Churchill River diversion reservoirs about five years after inundation; third, that mercury concentrations in populations of small fish in Churchill River diversion reservoirs were related to background (soil and sediment) mercury levels; and, fourth, that mercury concentrations in populations of small fish were related to local limnological conditions.

## MATERIALS AND METHODS

### STUDY SITES

The Churchill River diversion project in northern Manitoba was implemented over the period 1974-1977. About 75% of the flow of this river (or 760 $m^3 \cdot s^{-1}$) was diverted into the Nelson River basin for power production on the lower Nelson. The point of diversion was Southern Indian Lake and the diverted water followed the courses of the Rat and Burntwood River valleys before joining the Nelson River. See Bodaly et al. (1984b) and Newbury et al. (1984) for more complete descriptions of this project.

In 1981, sampling was conducted at 23 sites in the area of the Churchill River diversion (Fig. 1). Sites were chosen to encompass a broad range of flooded environments over the Churchill River diversion area and seven of the sites were adjacent to open water stations at which limnological parameters had been monitored over the period 1974-1978 (Hecky et al. 1979). Two of the sites were on lakes unaffected by the diversion: Granville Lake (coded on tables as G), on the Churchill River upstream of water control effects; and, East Mynarski Lake (EM), the eastern-most of a chain of three lakes located on a small tributary stream of the Rat River. Five sites were on Southern Indian Lake, which was raised 3 m in 1976 for the diversion of the Churchill River; Area 5 (5), Area 4 (4), Sandhill Bay (SA), Area 6 (South Bay) (6), and Wupaw Bay (WB). Five sites were part of the Notigi Reservoir in the Rat River valley, between Southern Indian Lake and the Notigi control structure. This reservoir flooded several lakes in the Rat River valley by 7-15 m over the period 1974-76: Issett Lake (I), on the upper Notigi Reservoir and raised by 7.6 m; Central Mynarski Lake (CM), the middle lake on the Mynarski chain, raised by 6.9 m; West Mynarski Lake (WM), the western-most lake on the Mynarski chain, raised by 9.0 m; the west basin of Notigi Lake (NW), and, the east basin of Notigi Lake (NE), both raised 15.2 m. One site was located on Footprint Lake (F), located on the Footprint River and flooded by 3.6 m as a result of the diverted Churchill River flows downstream of the Notigi control structure.

In 1982, sampling was conducted at seven sites (Fig. 1). Sites were chosen on the basis of the likelihood of concentrations of small fish and prevalence of mossy landscape. Six of the seven sites were on the same lake or lake basin as 1981 sites, but the precise locations usually differed from 1981; these six sites were Granville Lake, East Mynarski Lake, Area 5, Area 4, West Mynarski Lake, and Notigi Lake west basin. An additional site on Southern Indian Lake, Methyl Bay (MB), was added in 1982. Some additional spottail shiner samples were taken at the Wupaw Bay, Area 6 and Notigi Lake east basin sites.

In both years, a site was considered to consist of approximately 200 m of shoreline and adjacent areas of flooded shore (where present) and original lake bottom.

### SOIL AND VEGETATION SAMPLING

Sample cores of flooded and unflooded soil were taken with modified cork borers (or similar aluminum piping) with diameters of 2.8 cm and lengths of 4 cm. The borers were fitted with plungers or pistons for core removal. The core

samples were removed intact from the corer and stored frozen until analysis. Because of differences in the density of soil and moss materials cored, the actual depth of cores was variable.

In 1981, six samples were taken from each of unflooded soil, flooded soil (where present) and original lake sediment. Samples were taken at regularly spaced intervals along the length of each site.

In 1982, a set of 10 samples of unflooded soil and flooded soil (where present) was taken at each site. Each set of soil cores was taken within a small (10 m radius) area; unflooded and flooded soil samples were taken from adjacent areas. All cores were frozen within three days of recovery.

In the laboratory, frozen cores were thawed prior to separation into component soil horizon layers. A complete soil core was typically composed of three layers:

1. Moss/peat/litter - usually live green moss and/or brownish moss, sometimes lichen or broadleaf litter; structure of materials in this layer was generally distinguishable.

2. Ah horizon - brown or black colored humic rich soil horizon; vegetative structure not distinguishable.

3. Clay - brownish or gray predominately clay subsoil; sometimes contained some humus.

Not all layers were present in all cores. In particular, the clay layer was missing where the upper two layers were quite thick and the corer did not penetrate below the Ah horizon. Also, the upper moss/peat/litter layer had sometimes been eroded away by wave action from flooded soil cores.

In 1982, cores were separated into component layers according to naturally occurring divisions, as given above. In 1981, the top 2 cm of each core was removed as the first subsample; subsequent subsamples were taken according to naturally occurring divisions.

In 1981, six replicate lake sediment samples were taken at each site in a regular series adjacent to each paired sample of flooded and unflooded soil. Sediment samples were obtained using an Ekman dredge. A core was taken from the intact dredge sample to a depth of approximately 4.7 cm using a modified 50 cc disposable syringe.

Samples of representative vegetation were collected in July, 1976, as part of a study to estimate the biomass of vegetation to be flooded. Seven sites were sampled in Wupaw Bay, Southern Indian Lake (Fig. 1). The sites were chosen to represent the range of topographies, subsoils and vegetation covers that were inundated by the impoundment of Southern Indian Lake. The samples were dried after collection and subsequently analyzed for mercury content in February, 1983.

Sediment, vegetation, netplankton and soil subsamples were dried to constant weight at 100 C and then ground to a fine powder in a sample mill. Digestion of sediment and soil samples was carried out following the aqua regia procedure of Dow Chemical Co. of Canada Ltd. (Method CAS-AM-70.13). Vegetation and netplankton digestions used the potassium permanganate solution (Armstrong and Uthe 1971) to insure complete oxidation of organic matter. Total mercury content was determined by the atomic absorption spectrophotometry method of Armstrong and Uthe (1971). The analytical precision of total mercury determinations on dried material is ±0.024 at 0.6 $\mu g \cdot g^{-1}$ Hg and is ±0.010 at 0.1 $\mu g \cdot g^{-1}$ Hg while the detection limit is 0.005 $\mu g \cdot g^{-1}$.

## FISH SAMPLING

Samples of small fish were collected in shallow water at each site using a seine net pulled by hand. An attempt was made to collect at least one dozen spottail shiners and one dozen yellow perch, of similar sizes, at each site. Fish were placed in plastic bags and iced immediately after capture. Samples were frozen within two days of capture and stored frozen for 2-4 months before examination. Total length was determined on frozen fish to the nearest mm. While still frozen, the body musculature was removed from both sides of each fish. Mercury concentration in the musculature was determined by the atomic absorption spectrophotometry method of Armstrong and Uthe (1971). The analytical precision of total mercury determinations on fish muscle is ±0.008 at 0.10 $\mu g \cdot g^{-1}$ Hg while the detection limit is 0.005 $\mu g \cdot g^{-1}$.

In 1981, spottail shiners collected at 12 sites ranged in size from 26 to 106 mm total length. The mercury concentration values for individual fish were adjusted for fish size using the analysis of covariance procedure of Dixon and Massey (1969). The within groups regression line was calculated using log total length (mm) as the independent variable and log total mercury concentration ($\mu g \cdot g^{-1}$ wet weight) as the dependent variable. The residuals from this line were utilized as a measure of the mercury content for individual fish. Yellow perch collected in 1981 were similar in size among sites, ranging in mean total length from 46 to 66 mm and mercury concentration was therefore not adjusted for fish size for these samples. Similarly, the mercury content of spottail shiners and yellow perch taken in 1982 was not adjusted to fish size. Spottail shiners taken from 10 of the sites in 1982 ranged in mean total length from 70 to 81 mm while yellow perch from 7 of the sites ranged in mean total length from 62 to 75 mm.

## LIMNOLOGICAL SAMPLING

In 1981, a series of physical, chemical and biological parameters were determined at a station offshore of each soil sampling site (depth usually ≈5 m) three times over the open water season. Sample periods were: 1) 18-20 June, 2) 20-25 July, and 3) 17-24 August. The following parameters were determined: mean

temperature of the water column (to 5 m depth) (TEMP), total dissolved nitrogen (TDN), total dissolved phosphorus (TDP), total suspended solids (TSS), suspended phosphorus (SP), suspended nitrogen (SN), suspended carbon (SC), dissolved organic carbon (DOC), percent oxygen saturation (SAT), oxygen consumption in the water column (RESP), water conductivity (COND), water column light absorbance at 455 nm after filtration and centrifugation (ABS), absorbances at 543 nm of the unfiltered sample (UNFILT), the filtered sample (FILT), and filtered/centrifuged sample (CENT), rate of primary productivity (PROD), and total mercury concentration in the zooplankton fractions >73 µm (Z73), >153 µm(Z153), >351 µm (Z351) and >760 µm (Z760). In Tables 16 and 17, values for each parameter are presented for individual sampling times (denoted as the parameter code followed by 1, 2 or 3) and for the mean of the three sample times (denoted by the parameter code preceeded by M). For water column light absorbance measurements taken at 543 nm, correlations were calculated using the change in absorbance from the unfiltered sample, UNFILT, to the filtered sample, FILT (ΔFILT) and using the change in absorbance from the unfiltered sample, UNFILT, to the filtered/centrifuged sample, CENT, (ΔCENT).

Field sampling

Temperature and conductivity profiles from surface to bottom were made using a Montedoro-Whitney model CTU-3A temperature-conductivity meter. The mean depth of appearance and disappearance of a 25 cm Secchi disk divided into alternating black and white quadrants was also recorded. Water samples for chemical analyses and primary productivity estimates were taken with a sampler (Fee 1976) which integrated between the surface and five meters depth. The water samples were taken directly into opaque polypropylene two liter bottles and stored in insulated coolers until processing at the laboratory at the South Indian Lake research station. Light extinction profiles required for the calculation of integral primary productivity were measured as described in Hecky (1984) using a Li-Cor Instruments underwater quantum sensor and meter. Two sets of twin Nitex Wisconsin nets (described by Patalas and Salki (1984)) were towed horizontally for a minimum of three minutes (longer if plankton were sparse) to collect a sufficient quantity of plankton for mercury analysis. Four different mesh sizes were used (73, 153, 351, and 760 µm) in order to sample differentially the larger components of the plankton community. The plankton samples were transferred to glass jars and stored on ice until further processing at the laboratory.

Laboratory analyses

The netplankton samples were poured onto a 10 µm mesh sieve to drain off excess water, and they were then harvested from the sieve surface into 20 mL polyethylene scintillation vials. The vials were then stored frozen until analysis for mercury content at the Freshwater Institute. Integral primary productivity (PROD) was measured using the incubator-based, numerical integration method of Fee (1973) as applied by Hecky and Guildford (1984).

Unfiltered water was used for the analysis of pH, oxygen and dissolved inorganic carbon (DIC) while filtered and centrifuged water was used for the anlaysis of $NH_4^+$-N. The procedures used were those of Stainton et al. (1977). Oxygen titrations were performed using an amperometric end point. The reagents for the oxygen analysis were described by Carpenter (1965). Oxygen consumption estimates (RESP) are based on two replicate initial measurements which also serve for the percent saturation estimates (SAT) and two final replicate measurements made after incubation in the dark at ambient temperatures for approximately 24 h. Oxygen consumption rates are expressed on an hourly basis.

Water samples for analysis by the Analytical Unit of the Freshwater Institute in Winnipeg were filtered through GFC glass-fiber filters and then centrifuged. Absorbance at 543 nm was measured in 10 cm cells on a Bausch and Lomb model Spectronic 70 spectrophotometer before filtration, after filtration and after centrifugation to allow estimation of suspended particulate matter. After centrifugation absorbance was measured at 455 µm for humic color (Guildford 1984). For all absorbance measurements distilled deionized water served as the reference. Suspended carbon and nitrogen were analyzed from one filter while suspended phosphorus, total suspended solids and chlorophyll were analyzed from separate filters using the methods of Stainton et al. (1977). Filtered and centrifuged water was subsampled into 20 mL plastic vials for analysis of cations (preserved with 200 mL of 1 N CHl) and into 20 mL glass vials for the analysis of DOC, (preserved with 50 µL saturated $HgCl_2$) and TDN and TDP (preserved with 100 µL of 4 N $H_2SO_4$). Analysis methods followed Stainton et al. (1977).

ACKNOWLEDGMENTS

We thank the many individuals who assisted in the field and laboratory: S. Balchin, K. Cooper, S.J. Guildford, T.W.D. Johnson, D.S. MacDonell, G.K. McCullough, B. Parker, A.M. Tompkins, and M. Treble. We appreciate the help of M.J. Capel, S.M. Chalanchuk, and K.E. Marshall in reviewing the manuscript.

REFERENCES

ABERNATHY, A.R., and P.M. CUMBIE. 1977. Mercury accumulation by largemouth bass (Micropterus salmoides) in recently impounded reservoirs. Bull. Environ. Contam. Toxicol. 17(5): 595-602.

ARMSTRONG, F.A.J., and J.F. UTHE. 1971. Semi-automated determination of mercury in animal tissue. At. Absorpt. Newsl. 10: 101-103.

BODALY, R.A., and R.E. HECKY. 1979. Post-impoundment increases in fish mercury levels in the Southern Indian Lake

reservoir, Manitoba. Can. Fish. Mar. Serv. Manuscr. Rep. 1531: iv + 15 p.

BODALY, R.A., R.E. HECKY, and R.J.P. FUDGE. 1984a. Increases in fish mercury levels in lakes flooded by the Churchill River diversion, northern Manitoba. Can. J. Fish. Aquat. Sci. 41: 682-691.

BODALY, R.A., D.M. ROSENBERG, M.N. GABOURY, R.E. HECKY, R.W. NEWBURY, and K. PATALAS. 1984b. Ecological effects of hydroelectric development in northern Manitoba, Canada: The Churchill-Nelson River diversion, p. 273-310. In P.J. Sheehan, D.R. Miller, G.C. Butler and Ph. Bourdeau (ed.) Effects of pollutants at the ecosystem level. John Wiley and Sons, Chichester. (SCOPE 22).

BRUCE, W.J., and D. SPENCER. 1979. Mercury levels in Labrador fish, 1977-78. Can. Ind. Rep. Fish. Aquat. Sci. 111: iv + 12 p.

CARPENTER, J.H. 1965. The Chesapeake Bay Institute technique for the Winkler dissolved oxygen method. Limnol. Oceanogr. 10: 141-143.

COX, J.A., J. CARNAHAN, J. DINUNZIO, J. MCCOY, and J. MEISTER. 1979. Source of mercury in fish in new impoundments. Bull. Environ. Contam. Toxicol. 23: 779-783.

DIXON, W.J., and F.J. MASSEY. 1969. Introduction to statistical analysis. McGraw-Hill, New York.

FEE, E.J. 1973. Modelling primary production in water bodies: a numerical approach that allows for vertical inhomogeneities. J. Fish. Res. Board Can. 30: 1469-1473.

FEE, E.J. 1976. The vertical and seasonal distribution of chlorophyll in lakes of the Experimental Lakes Area, northwestern Ontario: implications for primary productivity estimates. Limnol. Oceanogr. 21: 767-783.

GUILDFORD, S.J. 1984. Depression of primary productivity by suspended sediment and dissolved humic material in limnocorral experiments at Southern Indian Lake, northern Manitoba. M.Sc. thesis, University of Manitoba, Winnipeg, MB. 191 p.

HECKY, R.E. 1984. Thermal and optical characteristics of Southern Indian Lake before, during and after impoundment and Churchill River diversion. Can. J. Fish. Aquat. Sci. 41: 579-590.

HECKY, R.E., and S.J. GUILDFORD. 1984. Primary productivity of Southern Indian Lake before, during, and after impoundment and Churchill River diversion. Can. J. Fish. Aquat. Sci. 41: 591-604.

HECKY, R.E., J. ALDER, C. AMEMA, K. BURRIDGE, and S.J. GUILDFORD. 1979. Physical data on Southern Indian Lake, 1974 through 1978, before and after impoundment and Churchill River diversion. Can. Fish. Mar. Serv. Data Rep. 158: iv + 523 p. (In two parts)

LODENIUS, M., A. SEPANEN, and M. HERRANEN. 1983. Accumulation of mercury in fish and man from reservoirs in northern Finland. Water Air Soil Pollut. 19: 237-246.

NEWBURY, R.W., G.K. MCCULLOUGH, and R.E. HECKY. 1984. The Southern Indian Lake impoundment and Churchill River diversion. Can. J. Fish. Aquat. Sci. 41: 548-557.

PATALAS, K., and A. SALKI. 1984. Effects of impoundment and diversion on the crustacean plankton of Southern Indian Lake. Can. J. Fish. Aquat. Sci. 41: 613-637.

POTTER, L., D. KIDD, and D. STANDIFORD. 1975. Mercury levels in Lake Powell. Bioamplification of mercury in man-made desert reservoirs. Environ. Sci. Technol. 9(1): 41-46.

STAINTON, M.P., M.J. CAPEL, and F.A.J. ARMSTRONG. 1977. Chemical analysis of freshwater. 2nd ed. Can. Fish. Mar. Serv. Misc. Spec. Publ. 25: 166 p.

WAITE, D.T., G.W. DUNN, and R.J. STEDWILL. 1980. Mercury in Cookson Reservoir (East Poplar River). Sask. Environ. Wat. Pollut. Control Branch W.P.C. 23: 19 p.

Table 1. Concentration of total mercury in upper 2 cm of unflooded soil (regardless of actual composition) from 13 sites in the area of the Churchill River diversion, 1981.

| Site | | mean total Hg conc. ($\mu g \cdot g^{-1}$ dry wt) | n | SD |
|---|---|---|---|---|
| 5 | (SIL* Area 5) | 0.099 | 6 | 0.019 |
| 4 | (SIL Area 4) | 0.109 | 6 | 0.049 |
| SA | (SIL Sandhill Bay) | 0.110 | 6 | 0.045 |
| WB | (SIL Wupaw Bay) | 0.114 | 6 | 0.029 |
| 6 | (SIL Area 6) | 0.083 | 7 | 0.027 |
| I | (Issett Lake) | 0.057 | 6 | 0.036 |
| G | (Granville Lake) | 0.119 | 6 | 0.085 |
| WM | (West Mynarski Lake) | 0.115 | 6 | 0.029 |
| CM | (Central Mynarski Lake) | 0.085 | 6 | 0.018 |
| EM | (East Mynarski Lake) | 0.055 | 6 | 0.047 |
| NW | (Notigi Lake, West basin) | 0.052 | 6 | 0.046 |
| NE | (Notigi Lake, East basin) | 0.169 | 6 | 0.074 |
| F | (Footprint Lake) | 0.079 | 9 | 0.035 |

* SIL = Southern Indian Lake

Table 2. Concentration of total mercury in unflooded soil horizons from 13 sites in the area of the Churchill River diversion, 1981.

| Horizon | Site* | Mean total Hg ($\mu g \cdot g^{-1}$ dry wt) | n | SD |
|---|---|---|---|---|
| moss/peat/litter | 5 | 0.099 | 6 | 0.019 |
| | 4 | 0.109 | 6 | 0.049 |
| | SA | 0.110 | 6 | 0.045 |
| | WB | 0.114 | 4 | 0.027 |
| | 6 | 0.083 | 6 | 0.028 |
| | I | 0.057 | 6 | 0.036 |
| | G | 0.119 | 7 | 0.078 |
| | WM | 0.115 | 6 | 0.029 |
| | CM | 0.085 | 6 | 0.018 |
| | EM | 0.055 | 6 | 0.047 |
| | NW | 0.052 | 6 | 0.046 |
| | NE | 0.169 | 3 | 0.113 |
| | F | 0.079 | 9 | 0.035 |
| Ah | 5 | 0.115 | 5 | 0.019 |
| | 4 | 0.126 | 6 | 0.051 |
| | SA | 0.110 | 6 | 0.011 |
| | WB | 0.093 | 4 | 0.021 |
| | 6 | 0.102 | 4 | 0.009 |
| | I | 0.021 | 5 | 0.020 |
| | G | 0.080 | 6 | 0.050 |
| | WM | 0.113 | 3 | 0.032 |
| | CM | 0.108 | 2 | 0.016 |
| | EM | 0.021 | 4 | 0.023 |
| | NW | 0.100 | 2 | 0.057 |
| | NE | 0.165 | 4 | 0.037 |
| | F | 0.127 | 3 | 0.051 |
| clay | 5 | 0.022 | 2 | 0.012 |
| | 4 | 0.035 | 1 | - |
| | SA | 0.030 | 1 | - |
| | WB | 0.056 | 5 | 0.026 |
| | 6 | 0.027 | 6 | 0.009 |
| | I | 0.027 | 4 | 0.015 |
| | G | 0.027 | 3 | 0.015 |
| | WM | 0.050 | 5 | 0.026 |
| | CM | 0.028 | 6 | 0.008 |
| | EM | 0.033 | 4 | 0.021 |
| | NW | 0.038 | 6 | 0.031 |
| | NE | 0.035 | 6 | 0.012 |
| | F | 0.037 | 9 | 0.014 |

* See Table 1 for key.

Table 3. Concentration of total mercury in unflooded soil horizons from 7 sites in the area of the Churchill River diversion, 1982.

| Horizon | Site | | Mean total Hg ($\mu g \cdot g^{-1}$ dry wt) | n | SD |
|---|---|---|---|---|---|
| moss/peat/litter | 5 | (SIL Area 5) | 0.115 | 12 | 0.048 |
| | 4 | (SIL Area 4) | 0.068 | 11 | 0.015 |
| | MB | (SIL Methyl Bay) | 0.104 | 10 | 0.021 |
| | G | (Granville Lake) | 0.156 | 10 | 0.051 |
| | EM | (East Mynarski Lake) | 0.062 | 5 | 0.014 |
| | WM | (West Mynarski Lake) | 0.207 | 3 | 0.025 |
| | NW | (Notigi Lake West basin) | 0.069 | 7 | 0.013 |
| Ah | 5 | | 0.174 | 8 | 0.063 |
| | 4 | | 0.075 | 8 | 0.017 |
| | MB | | 0.081 | 10 | 0.012 |
| | G | | 0.165 | 10 | 0.049 |
| | EM | | 0.094 | 10 | 0.022 |
| | WM | | 0.153 | 3 | 0.015 |
| | NW | | 0.075 | 10 | 0.020 |
| clay | 5 | | | - | |
| | 4 | | | - | |
| | MB | | 0.013 | 3 | 0.002 |
| | G | | | - | |
| | EM | | 0.045 | 8 | 0.017 |
| | WM | | 0.037 | 10 | 0.022 |
| | NW | | | - | |

Table 4. Concentration of total mercury in sediment samples from 13 sites in the area of the Churchill River diversion, 1981.

| Site* | Mean total Hg ($\mu g \cdot g^{-1}$ dry wt) | n | SD |
|---|---|---|---|
| 5 | 0.017 | 6 | 0.004 |
| 4 | 0.009 | 6 | 0.002 |
| SA | 0.014 | 6 | 0.002 |
| WB | 0.053 | 6 | 0.006 |
| 6 | 0.045 | 6 | 0.004 |
| I | 0.050 | 6 | 0.010 |
| G | 0.024 | 6 | 0.017 |
| WM | 0.058 | 6 | 0.013 |
| CM | 0.015 | 6 | 0.010 |
| EM | 0.020 | 6 | 0.003 |
| NW | 0.028 | 6 | 0.019 |
| NE | 0.014 | 6 | 0.003 |
| F | 0.060 | 6 | 0.004 |

* See Table 1 for key.

Table 5. Concentration of total mercury in flooded soil horizons from 11 sites in the area of the Churchill River diversion, 1981.

| Horizon | Site* | Mean total Hg ($\mu g \cdot g^{-1}$ dry wt) | n | SD |
|---|---|---|---|---|
| moss/peat/litter | 5 | 0.083 | 3 | 0.020 |
| | 4 | 0.067 | 1 | - |
| | SA | 0.088 | 3 | 0.030 |
| | I | 0.100 | 1 | - |
| | NW | 0.080 | 1 | - |
| | F | 0.094 | 3 | 0.015 |
| Ah | 5 | 0.060 | 4 | 0.027 |
| | 4 | 0.078 | 4 | 0.012 |
| | SA | 0.072 | 5 | 0.023 |
| | WB | 0.071 | 3 | 0.022 |
| | 6 | 0.084 | 6 | 0.028 |
| | I | 0.078 | 5 | 0.033 |
| | WM | 0.090 | 5 | 0.021 |
| | CM | 0.051 | 5 | 0.010 |
| | NW | 0.061 | 5 | 0.014 |
| | NE | 0.098 | 5 | 0.036 |
| | F | 0.073 | 6 | 0.018 |
| clay | 4 | 0.043 | 2 | 0.013 |
| | SA | 0.022 | 3 | 0.009 |
| | WB | 0.041 | 5 | 0.015 |
| | 6 | 0.035 | 6 | 0.013 |
| | I | 0.025 | 4 | 0.007 |
| | WM | 0.031 | 5 | 0.014 |
| | CM | 0.026 | 6 | 0.008 |
| | NW | 0.016 | 5 | 0.002 |
| | NE | 0.026 | 4 | 0.007 |
| | F | 0.032 | 9 | 0.021 |

* See Table 1 for key.

Table 6. Concentration of total mercury in flooded soil horizons from five sites in the area of the Churchill River diversion, 1982.

| Horizon | Site* | Mean total Hg ($\mu g \cdot g^{-1}$ dry wt) | n | SD |
|---|---|---|---|---|
| moss/peat/litter | 5 | 0.158 | 9 | 0.036 |
| | 4 | 0.080 | 6 | 0.012 |
| | MB | 0.117 | 8 | 0.019 |
| | WM | 0.068 | 6 | 0.016 |
| | NW | 0.047 | 1 | - |
| Ah | 5 | 0.148 | 6 | 0.012 |
| | 4 | 0.064 | 5 | 0.010 |
| | MB | 0.130 | 10 | 0.024 |
| | WM | 0.089 | 9 | 0.019 |
| | NW | 0.069 | 10 | 0.022 |
| clay | MB | 0.082 | 2 | 0.054 |
| | WM | 0.034 | 8 | 0.012 |
| | NW | 0.031 | 9 | 0.006 |

* See Table 3 for key.

Table 7. Mercury, carbon, phosphorus and nitrogen content of unflooded vegetation from Wupaw Bay, Southern Indian Lake, 1976. Replicate analyses are given for some nitrogen determinations. See Fig. 1 for site locations.

| Species | Part | Sample no. | Total Hg ($\mu g \cdot g^{-1}$) | Carbon ($\mu g \cdot mg^{-1}$) | Phosphorus ($\mu g \cdot mg^{-1}$) | Nitrogen ($\mu g \cdot mg^{-1}$) | Site | Identity | Height (m) | Diameter at 1.4 m (cm) | Description or sample location on tree |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Picea mariana | wood | 87 | <0.005 | 514 | 0.09 | 0.51, 0.55 | WB4 | TK | 2.2 | 2.2 | •lower bole |
| | | 98 | 0.008 | 492 | 0.07 | 0.23, 0.41 | WB1 | T2 | 16.0 | 21.8 | •bole at 8 m |
| | bark | 88 | 0.019 | 542 | 0.21 | 1.54 | WB4 | TK | 2.2 | 2.2 | •lower bole |
| | | 100 | 0.023 | 521 | 0.32 | 2.37 | WB1 | T1 | 8.5 | 7.6 | •bole at 0.1 m |
| | | 99 | 0.029 | 506 | 0.35 | 2.60, 2.34 | WB2 | T8 | 6.5 | 8.1 | •branches at 1 to 1.2 m |
| | twigs | 19 | 0.070 | 491 | 0.43 | 4.14 | WB1 | T4 | 2.8 | 2.9 | •0 to 1 m |
| | | 20 | 0.039 | 502 | 0.59 | 3.87 | WB1 | T2 | 16.0 | 21.8 | •7.8 to 8 m |
| | | 9 | 0.039 | 409 | 0.45 | - | WB4 | T16 | 4.7 | 4.8 | - |
| | foliage | 21 | 0.014 | 501 | 0.50 | 5.26 | WB4 | T15 | 2.0 | 1.9 | •1 to 1.2 m |
| | | 22 | 0.012 | 453 | 0.68 | 4.20, 4.50 | WB2 | T8 | 6.5 | 8.1 | •1 to 1.2 m |
| | | 24 | 0.065 | 457 | 0.66 | 5.11 | WB1 | T4 | 2.8 | 2.9 | •0 to 1 m |
| | | 25 | 0.010 | 304 | 0.68 | 5.86 | WB1 | T1 | 8.5 | 7.6 | •7 to 7.2 m |
| | | 23 | 0.010 | 462 | 0.69 | 5.63 | WB1 | T2 | 16.0 | 21.8 | •7.8 to 8 m |
| | | 8 | 0.011 | 334 | 0.52 | - | WB4 | T16 | 4.7 | 4.8 | - |
| Populus tremuloides | wood | 94 | <0.005 | 533 | 0.03 | 0.48 | WB6 | T30 | 10.6 | 12.4 | •bole at 0.2 to 0.3 m |
| | bark | 92 | 0.018 | 505 | 0.30 | 2.41, 2.67 | WB5 | T29 | 4.3 | 3.4 | •bole at 0 to 0.2 m |
| | | 93 | 0.011 | 328 | 0.78 | 3.13 | WB6 | T30 | 10.6 | 12.4 | •bole at 5 to 5.1 m |
| | twigs | 30 | 0.014 | 491 | 0.48 | 5.66, 6.36 | WB5 | T29 | 4.3 | 3.4 | •3 to 3.2 m |
| | | 32 | <0.005 | 503 | 0.66 | 4.78 | WB6 | T30 | 10.6 | 12.4 | •5 to 5.2 m |

Table 7. Cont'd.

| Species | Part | Sample no. | Total Hg ($\mu g \cdot g^{-1}$) | Carbon ($\mu g \cdot mg^{-1}$) | Phosphorus ($\mu g \cdot mg^{-1}$) | Nitrogen ($\mu g \cdot mg^{-1}$) | Site | Identity | Height (m) | Diameter at 1.4 m (cm) | Description or sample location on tree |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Populus tremuloides | foliage | 31 | 0.011 | 485 | 1.43 | 18.36 | WB5 | T29 | 4.3 | 3.4 | •3 to 3.2 m |
| | | 33 | 0.013 | 486 | 1.73 | 17.58 | WB6 | T30 | 10.6 | 12.4 | •5 to 5.2 m |
| | | 11 | 0.013 | 223 | 1.54 | - | WB5 | T28 | 7.2 | 7.8 | - |
| Populus balsamifera | wood | 84 | 0.005 | 459 | 0.21 | 2.05 | WB11 | T52 | 6.9 | 6.4 | •bole at 2.7 m |
| | bark | 85 | 0.018 | 499 | 0.84 | 5.14, 6.58 | WB11 | T52 | 6.9 | 6.4 | •bole at 2.7 m |
| | | 86 | <0.005 | 514 | 1.16 | 6.71 | WB11 | T51 | 10.6 | 13.3 | •bole at 9.1 m |
| | twigs | 60 | 0.014 | 463 | 1.08 | 5.76, 8.76 | WB11 | T52 | 6.9 | 6.4 | •at 5.5 m |
| | | 62 | 0.014 | 492 | 0.79 | 4.64, 6.68 | WB11 | T52 | 6.9 | 6.4 | •at 6.4 to 6.6 m |
| | foliage | 61 | 0.020 | 443 | 2.38 | 3.41, 4.01 | WB11 | T52 | 6.9 | 6.4 | •at 5.5 m |
| | | 63 | 0.023 | 442 | 2.40 | 5.71 | WB11 | T51 | 10.6 | 13.3 | •6.4 to 6.6 m |
| | | 64 | 0.027 | 436 | 3.47 | 8.64, 9.92 | WB11 | T51 | 10.6 | 13.3 | •8.2 to 8.4 m |
| Betula papyrifera | wood | 91 | 0.015 | 333 | 0.13 | 0.77, 0.93 | WB2 | T1 | 8.5 | 9.4 | •bole at 0.3 to 0.4 m |
| | bark | 89 | 0.008 | 545 | 0.26 | 3.61 | WB2 | T2 | 5.5 | 5.4 | •bole at 2 to 2.1 m |
| | | 90 | 0.005 | 560 | 0.31 | 2.80, 2.98 | WB3 | T12 | 6.4 | 6.2 | •bole at 7.6 cm diameter |
| | twigs | 50 | 0.034 | 490 | 0.37 | 1.85, 2.47 | WB2 | T2 | 5.5 | 5.4 | •3 to 3.2 m |
| | | 52 | 0.024 | 484 | 0.56 | 1.44, 2.60 | WB3 | T12 | - | - | •4.1 to 4.3 m |
| | foliage | 51 | 0.012 | 463 | 1.49 | 6.67, 8.13 | WB2 | T2 | 5.5 | 5.4 | •3 to 3.2 m |
| | | 53 | 0.016 | 479 | 1.09 | 4.89 | WB3 | T12 | 6.4 | 6.2 | •4.1 to 4.3 m |

Table 7. Cont'd.

| Species | Part | Sample no. | Total Hg ($\mu g \cdot g^{-1}$) | Carbon ($\mu g \cdot mg^{-1}$) | Phosphorus ($\mu g \cdot mg^{-1}$) | Nitrogen ($\mu g \cdot mg^{-1}$) | Site | Identity | Height (m) | Diameter at 1.4 m (cm) | Description or sample location on tree |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pinus banksiana | wood | 95 | <0.005 | 489 | 0.02 | 0.38 | WB3 | T14 | 6.2 | 7.6 | •bole at 2.6 to 2.7 m |
| | bark | 97 | 0.018 | 552 | 0.19 | 2.04 | WB3 | T14 | 6.2 | 7.6 | •bole at 1.5 to 2.5 m |
| | | 96 | 0.013 | 512 | 0.21 | 2.09 | WB3 | T14 | 6.2 | 7.6 | •bole at 2.6 to 2.7 m |
| | twigs | 27 | 0.012 | 520 | 0.48 | 3.99 | WB3 | T13 | 6.5 | 7.8 | •3 to 3.2 m |
| | | 29 | 0.007 | 509 | 0.40 | 3.47 | WB3 | T14 | 6.2 | 7.6 | •5 to 5.2 m |
| | foliage | 26 | <0.005 | 470 | 0.62 | 5.86 | WB3 | T13 | 6.5 | 7.8 | •3 to 3.2 m |
| | | 28 | <0.005 | 507 | 0.59 | 6.58 | WB3 | T14 | 6.2 | 7.6 | •5 to 5.2 m |
| Salix sp.[a] | wood | 81 | <0.005 | 510 | 0.45 | 1.42, 1.84 | WB4 | W24.4 | 2.5 | 2.2 | •large branch |
| | | - | - | 481 | 0.28 | - | - | R | - | - | - |
| | bark | 83 | 0.016 | 404 | 0.43 | 4.11, 4.83 | WB2 | T7 | 1.9 | 1.8 | •bole near base |
| | | 82 | 0.012 | 497 | 0.75 | 9.8, 11.2 | WB4 | W24.4 | 2.5 | 2.2 | •large branch |
| Salix sp. | twigs | 57 | <0.005 | 465 | 1.17 | 4.34, 5.20 | WB4 | W18 | 1.8 | 1.1 | •0.5 m to top |
| Salix cordata | | 59 | 0.017 | 427 | 0.77 | 2.91, 5.45 | WB2 | T5 | 4.7 | 3.0 | •2.5 m to top |
| Salix sp. | foliage | 56 | 0.012 | 445 | 2.39 | 14.7, 24.3 | WB4 | W18 | 1.8 | 1.1 | •0.5 m to top |
| | | 10 | 0.017 | 278 | 1.53 | - | WB4 | W19 | 3.1 | 2.2 | - |
| | | 54 | 0.010 | 428 | 1.56 | 15.6, 26.2 | WB4 | W27.3 | 1.9 | 1.8 | - |
| | | 55 | 0.012 | 385 | 2.85 | 15.6, 18.0 | WB2 | 02.2 | 0.7 | - | - |
| Salix cordata | | 58 | 0.012 | 430 | 1.86 | 6.78, 7.60 | WB2 | T5 | 4.7 | 3.0 | •2.5 m to top |

Table 7. Cont'd.

| Species | Part | Sample no. | Total Hg ($\mu g \cdot g^{-1}$) | Carbon ($\mu g \cdot mg^{-1}$) | Phosphorus ($\mu g \cdot mg^{-1}$) | Nitrogen ($\mu g \cdot mg^{-1}$) | Site | Identity | Height (m) | Diameter at 1.4 m (cm) | Description or sample location on tree |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alnus sp. | wood | 78 | 0.006 | 483 | 0.24 | 1.99, 2.85 | WB2 | 05.3 | 2.7 | - | •large branch |
| | bark | 79 | 0.010 | 657 | 0.56 | 10.1 | WB2 | 05.3 | 2.7 | - | •large branch |
| | | 80 | 0.011 | 484 | 0.30 | 7.19, 8.29 | WB3 | 02 | - | - | •small branch |
| | twigs | 75 | 0.013 | 536 | 1.50 | 6.02, 11.8 | WB2 | 01.2 | 0.4 | - | - |
| | | 76 | 0.014 | 518 | 1.00 | 12.5, 13.1 | WB2 | 04.2 | 1.4 | - | - |
| | | 65 | 0.016 | 505 | 0.74 | 9.2, 11.4 | WB2 | 05.3 | 2.7 | - | - |
| | | 67 | 0.012 | 524 | 0.37 | 7.68, 9.04 | WB3 | 02 | - | - | - |
| | foliage | 3 | 0.010 | 316 | 1.68 | - | WB2 | 05.3 | - | - | - |
| | | 74 | 0.026 | 467 | 2.88 | 32.1 | WB2 | 01.2 | 0.4 | - | - |
| | | 77 | 0.018 | 443 | 1.57 | 28.5 | WB2 | 04.2 | 1.4 | - | - |
| | | 66 | 0.013 | 437 | 1.64 | 21.0, 25.6 | WB2 | 05.2 | 2.2 | - | - |
| | | 68 | 0.017 | 466 | 0.77 | 13.6, 21.0 | WB3 | 02 | - | - | - |
| Ledum groenlandicum | twigs | 7 | 0.013 | 408 | 0.21 | - | WB3 | 01 | - | - | - |
| | | 70 | 0.023 | 538 | 0.56 | 5.12, 5.52 | WB3 | 02 | - | - | - |
| | | 71 | 0.015 | 469 | 0.50 | 4.78 | WB4 | 07 | - | - | - |
| | foliage | 6 | 0.015 | 376 | 1.16 | - | WB3 | 01 | - | - | - |
| | | 69 | 0.015 | 531 | 1.29 | 13.9 | WB3 | 02 | - | - | - |
| | | 72 | 0.020 | 469 | 1.12 | 13.7 | WB4 | 07 | - | - | - |
| | | 73 | 0.022 | 265 | 1.02 | 12.7 | WB4 | 05 | - | - | - |
| Sphagnum spp. | | 12 | 0.034 | 328 | 0.53 | - | WB7 | 02 | - | - | - |
| | | 46 | 0.13 | 448 | 0.65 | 8.51 | - | - | - | - | - |
| | | 47 | 0.054 | 428 | 0.48 | 4.73 | WB1 | 015 | - | - | - |
| | | 48 | 0.022 | 398 | 0.27 | 4.78 | WB4 | 03 | - | - | - |
| | | 49 | 0.047 | 411 | 0.34 | 2.05 | WB4 | 03 | - | - | - |

Table 7. Cont'd.

| Species | Part | Sample no. | Total Hg ($\mu g \cdot g^{-1}$) | Carbon ($\mu g \cdot mg^{-1}$) | Phosphorus ($\mu g \cdot mg^{-1}$) | Nitrogen ($\mu g \cdot mg^{-1}$) | Site | Identity | Height (m) | Diameter at 1.4 m (cm) | Description or sample location on tree |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Feather mosses | | 42 | 0.093 | 411 | 0.91 | 6.32 | WB1 | Q8 | - | - | - |
| | | 43 | 0.053 | 440 | 1.16 | 7.91 | WB6 | Q10 | - | - | •green |
| | | 44 | 0.073 | 412 | 0.66 | 4.99, 5.33 | WB4 | - | - | - | - |
| | | 45 | 0.010 | 396 | 1.04 | 5.71 | WB1 | - | - | - | - |
| Litter and organic soil horizon | | 1 | 0.064 | 257 | 0.67 | - | WB1 | - | - | - | - |
| | | 4 | 0.083 | 195 | 1.00 | - | WB2 | Q1 | - | - | - |
| | | | - | 384 | 0.86 | 14.70 | WB2 | Q4 | - | - | - |
| | | 35 | 0.046 | 446 | 0.89 | 16.01 | WB2 | Q5 | - | - | - |
| | | 36 | 0.039 | 483 | 0.45 | 8.60 | WB3 | Q2 | - | - | - |
| | | 37 | 0.058 | 481 | 0.66 | 8.87 | WB6 | - | - | - | - |
| | | 38 | 0.059 | 474 | 0.92 | 8.36 | WB1 | - | - | - | - |
| | | | | | | | | | | | •dominately Picea twigs and feather mosses |
| | | 39 | 0.093 | 449 | 0.67 | 9.96, 10.84 | WB1 | Q8 | - | - | •with considerable feather mosses |
| | | | - | 466 | 0.57 | 12.60 | WB4 | Q1 | - | - | •no Sphagnum |
| | | 41 | 0.094 | 473 | 0.78 | 9.34 | WB7 | Q1 | - | - | - |

[a] Salix sp.: diameter measured at 0.5 m above base (except Salix cordata).

Table 8. Concentration of total mercury in spottail shiner muscle from 12 sites in the area of the Churchill River diversion, 1981.

| Site* | n | Mean total mercury conc ($\mu g \cdot g^{-1}$) (range) | Mean total length of fish sample (mm) (range) | Residual from "within groups" regression of log [Hg] vs length (SD) |
|---|---|---|---|---|
| 5 | 12 | 0.38 (0.27-0.46) | 94.1 (88-106) | +0.333 (0.064) |
| 4 | 9 | 0.19 (0.16-0.25) | 47.4 (40-56) | +0.186 (0.085) |
| SA | 8 | 0.12 (0.11-0.14) | 65.9 (60-71) | -0.076 (0.045) |
| WB | 12 | 0.06 (0.05-0.07) | 47.2 (40-62) | -0.315 (0.065) |
| 6 | 12 | 0.13 (0.07-0.19) | 51.5 (44-59) | -0.004 (0.128) |
| G | 12 | 0.06 (0.05-0.08) | 42.2 (40-45) | -0.282 (0.057) |
| WM | 10 | 0.14 (0.09-0.23) | 81.6 (73-87) | -0.083 (0.110) |
| CM | 12 | 0.13 (0.11-0.18) | 79.0 (74-85) | -0.084 (0.066) |
| EM | 9 | 0.08 (0.06-0.11) | 54.3 (44-71) | -0.218 (0.071) |
| NW | 8 | 0.18 (0.16-0.20) | 30.6 (29-32) | +0.259 (0.034) |
| NE | 8 | 0.19 (0.17-0.24) | 29.0 (26-31) | +0.294 (0.061) |
| F | 18 | 0.17 (0.08-0.26) | 60.9 (37-80) | +0.085 (0.102) |

* See Table 1 for key.

Table 9. Concentration of total mercury in yellow perch muscle from seven sites in the area of the Churchill River diversion, 1981.

| Site* | n | Mean total mercury conc ($\mu g \cdot g^{-1}$) (range) | Mean total length of fish sample (mm) (range) |
|---|---|---|---|
| 5 | 8 | 0.08 (0.03-0.18) | 49.0 (38-65) |
| I | 12 | 0.05 (0.03-0.07) | 60.2 (55-65) |
| G | 8 | 0.03 (0.02-0.04) | 66.0 (58-90) |
| WM | 12 | 0.07 (0.06-0.11) | 53.5 (48-59) |
| CM | 12 | 0.08 (0.06-0.10) | 55.8 (51-60) |
| EM | 12 | 0.03 (0.03-0.04) | 46.0 (42-55) |
| F | 24 | 0.15 (0.10-0.18) | 55.2 (47-60) |

* See Table 1 for key.

Table 10. Concentration of total mercury in spottail shiner muscle from 10 sites in the area of the Churchill River diversion, 1982.

| Site* | n | Mean total mercury conc ($\mu g \cdot g^{-1}$) (range) (SD) | | | Mean total length of fish sample (mm) (range) | |
|---|---|---|---|---|---|---|
| 5 | 12 | 0.15 | (0.12-0.20) | (0.02) | 70.2 | (64-80) |
| 4 | 12 | 0.15 | (0.09-0.21) | (0.04) | 72.3 | (60-79) |
| MB | 12 | 0.11 | (0.05-0.16) | (0.03) | 71.2 | (66-79) |
| WB | 5 | 0.10 | (0.09-0.11) | (0.01) | 81.2 | (67-93) |
| 6 | 12 | 0.10 | (0.07-0.15) | (0.02) | 72.7 | (65-84) |
| G | 12 | 0.05 | (0.03-0.07) | (0.01) | 74.2 | (68-79) |
| WM | 12 | 0.15 | (0.11-0.20) | (0.03) | 74.6 | (66-86) |
| EM | 12 | 0.05 | (0.03-0.06) | (0.01) | 70.8 | (63-79) |
| NW | 12 | 0.19 | (0.16-0.24) | (0.02) | 75.1 | (71-80) |
| NE | 12 | 0.24 | (0.12-0.32) | (0.06) | 76.2 | (72-81) |

* See Table 3 for key.

Table 11. Concentration of total mercury in yellow perch muscle from seven sites in the area of the Churchill River diversion, 1982.

| Site* | n | Mean total mercury conc ($\mu g \cdot g^{-1}$) (range) (SD) | Mean total length of fish sample (mm) (range) |
|---|---|---|---|
| 5 | 12 | 0.09 (0.06-0.13) (0.02) | 62.3 (58-70) |
| 4 | 7 | 0.11 (0.08-0.15) (0.03) | 64.3 (62-70) |
| MB | 12 | 0.06 (0.03-0.11) (0.02) | 62.5 (58.72) |
| G | 12 | 0.02 (0.01-0.03) (0.01) | 71.1 (65-77) |
| WM | 12 | 0.11 (0.06-0.27) (0.06) | 65.5 (57-72) |
| EM | 12 | 0.02 (0.01-0.04) (0.01) | 74.8 (64-81) |
| NW | 12 | 0.18 (0.14-0.25) (0.04) | 65.7 (64-70) |

* See Table 3 for key.

Table 12. Major dissolved constituents at 1981 sampling sites; Na, K, Ca, Mg, Cl, $SO_4$, dissolved inorganic carbon (DIC), pH and specific conductance (COND) at 13 sites in the area of the Churchill River diversion, 1981. The analytical number (Anal #) is an internal reference number.

| Location | Date | Anal# | Na | K | Ca | Mg | Cl | $SO_4$ | DIC | pH | COND |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | µm/L | | | | | µS/cm |
| G | 19-Jun | 35 | 84 | 21.3 | 179 | 92 | 35 | 242 | 576 | NA | 112 |
| | 25-Jul | 111 | 96 | 24.4 | 171 | 98 | 20 | 36 | 686 | 7.83 | 66 |
| | 18-Aug | 207 | 107 | 24.3 | 185 | 108 | 17 | 80 | 585 | 8.01 | 68 |
| MEAN | | | 96 | 23.4 | 179 | 100 | 24 | 119 | 616 | 7.92 | 82 |
| 6 | 19-Jun | 33 | 101 | 22.4 | 216 | 116 | 25 | 39 | 747 | NA | 83 |
| | 25-Jul | 113 | 105 | 26.5 | 251 | 121 | 23 | 36 | 952 | 8.08 | 85 |
| | 18-Aug | 208 | 101 | 23.8 | 248 | 121 | 20 | 39 | 772 | 8.08 | 83 |
| MEAN | | | 102 | 24.2 | 238 | 119 | 23 | 38 | 824 | 8.08 | 84 |
| 4 | 19-Jun | 31 | 89 | 20.8 | 377 | 152 | NA | NA | 1130 | NA | 122 |
| | 25-Jul | 109 | 92 | 22.8 | 364 | 152 | 20 | 36 | 1310 | 8.12 | 116 |
| | 18-Aug | 205 | 79 | 19.8 | 375 | 160 | 11 | 61 | 987 | 8.17 | 116 |
| MEAN | | | 86 | 21.1 | 372 | 155 | 16 | 49 | 1142 | 8.15 | 118 |
| 5 | 19-Jun | 30 | 61 | 16.7 | 327 | 141 | 23 | 32 | 992 | NA | 100 |
| | 25-Jul | 108 | 70 | 17.4 | 311 | 135 | 17 | 36 | 1050 | 7.86 | 94 |
| | 18-Aug | 204 | 69 | 18.7 | 335 | 154 | 17 | 35 | 780 | 7.97 | 102 |
| MEAN | | | 67 | 17.6 | 325 | 143 | 19 | 35 | 941 | 7.92 | 99 |
| SA | 19-Jun | 32 | 44 | 17.2 | 243 | 98 | 28 | 36 | 679 | NA | 76 |
| | 25-Jul | 110 | 64 | 20.3 | 282 | 119 | 14 | 37 | 944 | 7.80 | 88 |
| | 18-Aug | 206 | 68 | 19.2 | 314 | 133 | 11 | 72 | 734 | 8.18 | 95 |
| MEAN | | | 59 | 18.9 | 280 | 117 | 18 | 49 | 786 | 7.99 | 86 |

Table 12. Cont'd.

| Location | Date | Anal# | Na | K | Ca | Mg | Cl | $SO_4$ | DIC | pH | COND |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | µm/L | | | | | µS/cm |
| NW | 18-Jun | 24 | 103 | 23.4 | 253 | 129 | 28 | 37 | 860 | NA | 87 |
| | 24-Jul | 107 | 106 | 25.2 | 235 | 117 | 25 | 35 | 807 | NA | 85 |
| | 17-Aug | 195 | 107 | 23.2 | 264 | 131 | 20 | 40 | 812 | 8.08 | 84 |
| MEAN | | | 105 | 24.0 | 251 | 126 | 24 | 37 | 826 | NA | 85 |
| NE | 18-Jun | 25 | 101 | 22.9 | 280 | 131 | 11 | 229 | 962 | NA | 112 |
| | 24-Jul | 106 | 108 | 26.5 | 251 | 123 | 23 | 37 | 845 | NA | 85 |
| | 17-Aug | 196 | 109 | 23.2 | 245 | 125 | 20 | 39 | 783 | 8.13 | 84 |
| MEAN | | | 106 | 24.2 | 259 | 126 | 18 | 102 | 863 | NA | 94 |
| F | 18-Jun | 26 | 88 | 25.5 | 536 | 200 | 11 | 233 | 1560 | NA | 160 |
| | 24-Jul | 105 | 103 | 28.1 | 530 | 204 | 20 | 45 | 1420 | NA | 156 |
| | 17-Aug | 194 | 104 | 31.1 | 541 | 212 | 17 | 46 | 1460 | 8.40 | 156 |
| MEAN | | | 98 | 28.3 | 536 | 205 | 16 | 108 | 1480 | NA | 157 |
| EM | 18-Jun | 27 | 73 | 22.4 | 446 | 168 | 11 | 235 | 1300 | NA | 137 |
| | 23-Jul | 101 | 83 | 24.0 | 438 | 173 | 11 | 87 | 1520 | 6.95 | NA |
| | 17-Aug | 197 | 84 | 21.5 | 396 | 162 | 11 | 40 | 1140 | 8.33 | 122 |
| MEAN | | | 80 | 22.6 | 427 | 168 | 11 | 121 | 1320 | 7.64 | 130 |
| CM | 18-Jun | 28 | 79 | 26.5 | 438 | 177 | 23 | 39 | 1400 | NA | 134 |
| | 23-Jul | 102 | 87 | 28.5 | 433 | 179 | 8 | 96 | 1690 | 6.97 | NA |
| | 17-Aug | 198 | 90 | 27.2 | 443 | 193 | 11 | 41 | 1250 | 8.31 | 133 |
| MEAN | | | 85 | 27.4 | 438 | 183 | 14 | 58 | 1447 | 7.64 | 134 |

Table 12. Cont'd.

| Location | Date | Anal# | Na | K | Ca | Mg | Cl | $SO_4$ | DIC | pH | COND |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | µm/L | | | | | µS/cm |
| WM | 18-Jun | 29 | 83 | 28.1 | 433 | 177 | 25 | 39 | 1460 | NA | 139 |
| | 23-Jul | 103 | 88 | 30.2 | 462 | 191 | 8 | 74 | 1640 | 6.95 | NA |
| | 17-Aug | 199 | 93 | 27.7 | 425 | 189 | 17 | 39 | 1200 | 8.30 | 128 |
| MEAN | | | 88 | 28.7 | 440 | 186 | 17 | 50 | 1433 | 7.63 | 134 |
| I | 19-Jun | 34 | 90 | 42.7 | 396 | 189 | 42 | 247 | 1300 | NA | 136 |
| | 25-Jul | 112 | 92 | 43.5 | 375 | 187 | 14 | 37 | 1410 | 7.78 | 120 |
| | 18-Aug | 209 | 97 | 46.4 | 385 | 191 | 20 | 79 | 1280 | 8.12 | 122 |
| MEAN | | | 93 | 44.2 | 385 | 189 | 25 | 121 | 1330 | 7.95 | 126 |
| WB | 20-Jun | 43 | 90 | 21.3 | 219 | 112 | 20 | 49 | 707 | NA | 81 |
| | 20-Jul | 92 | 99 | 22.8 | 237 | 117 | 20 | 37 | 831 | NA | 90 |
| | 24-Aug | 237 | 105 | 24.9 | 266 | 129 | 20 | 39 | 870 | 7.93 | 89 |
| MEAN | | | 98 | 23.0 | 241 | 119 | 20 | 42 | 803 | NA | 87 |

Table 13. Dissolved and suspended constituents at 1981 sampling sites; Fe, Mn, total dissolved nitrogen (TDN), total dissolved phosphorous (TDP), $NH_4$, dissolved organic carbon (DOC), suspended nitrogen (SN), suspended phosporous (SP) and chlorophyll-a (Chl-a) at 13 sites in the area of the Churchill River diversion, 1981. The analytical number (Anal #) is an internal reference number.

| Location | Date | Anal# | Fe | Mn | TDN | TDP | $NH_4$ | DOC | SC | SN | SP | Chl-a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | µm/L | | | | | | | | | µg/L |
| G | 19-Jun | 35 | 1.13 | <0.36 | 21 | 0.19 | 0.10 | 1980 | 29.7 | 3.4 | 0.26 | 2.3 |
| | 25-Jul | 111 | 1.10 | <0.36 | NA | NA | 0.33 | 560 | 37.8 | 1.5 | 0.32 | 4.3 |
| | 18-Aug | 207 | <0.36 | <0.18 | NA | NA | 0.23 | 970 | 48.5 | 6.7 | 0.37 | 3.7 |
| MEAN | | | <0.86 | <0.30 | NA | NA | 0.22 | 1170 | 38.7 | 3.9 | 0.32 | 3.4 |
| 6 | 19-Jun | 33 | 0.75 | <0.36 | 20 | 0.13 | 0.11 | 680 | 27.0 | 3.4 | 0.27 | 1.5 |
| | 25-Jul | 113 | 2.20 | <0.36 | NA | NA | 0.53 | 530 | 28.0 | 2.6 | 0.39 | 4.7 |
| | 18-Aug | 208 | <0.36 | 2.68 | NA | NA | 0.20 | 550 | 25.3 | 3.8 | 0.32 | 1.8 |
| MEAN | | | <1.10 | <1.14 | NA | NA | 0.28 | 587 | 26.8 | 3.3 | 0.33 | 2.7 |
| 4 | 19-Jun | 31 | 0.75 | <0.36 | 23 | 0.39 | 0.25 | 490 | 21.7 | 2.4 | 0.34 | 2.1 |
| | 25-Jul | 109 | 1.65 | <0.36 | NA | NA | 0.32 | 600 | 28.7 | 4.1 | 0.28 | 3.0 |
| | 18-Aug | 205 | <0.36 | <0.18 | NA | NA | 0.20 | 1150 | 26.0 | 3.9 | 0.30 | 2.0 |
| MEAN | | | <0.92 | <0.30 | NA | NA | 0.26 | 747 | 25.4 | 3.5 | 0.31 | 2.4 |
| 5 | 19-Jun | 30 | 0.38 | 0.36 | 23 | 0.13 | 0.33 | 640 | 58.2 | 5.8 | 0.28 | 2.8 |
| | 25-Jul | 108 | 1.10 | <0.36 | NA | NA | 0.36 | 670 | 35.7 | 6.0 | 0.36 | 3.1 |
| | 18-Aug | 204 | <0.36 | <0.18 | NA | NA | 0.26 | 660 | 41.2 | 5.7 | 0.30 | 3.3 |
| MEAN | | | <0.61 | <0.30 | NA | NA | 0.32 | 657 | 45.0 | 5.8 | 0.31 | 3.1 |
| SA | 19-Jun | 32 | 1.50 | <0.36 | 24 | 0.23 | 0.20 | 970 | 29.8 | 3.5 | 0.27 | 2.2 |
| | 25-Jul | 110 | 1.65 | <0.36 | NA | NA | 0.29 | 770 | 58.8 | 11.1 | 0.36 | 6.8 |
| | 18-Aug | 206 | 0.88 | <0.18 | NA | NA | 0.16 | 1050 | 45.3 | 6.3 | 0.39 | 3.9 |
| MEAN | | | 1.35 | <0.30 | NA | NA | 0.22 | 930 | 44.7 | 7.0 | 0.34 | 4.3 |

Table 13. Cont'd.

| Location | Date | Anal# | Fe | Mn | TDN | TDP | NH4 | DOC | SC | SN | SP | Chl-a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | µm/L | | | | | µg/L |
| NW | 18-Jun | 24 | 0.75 | 0.36 | 22 | 0.16 | 0.51 | 610 | 35.5 | 4.3 | 0.26 | 1.3 |
| | 24-Jul | 107 | 1.10 | <0.36 | NA | NA | 0.54 | 600 | 23.2 | 3.0 | 0.26 | 2.6 |
| | 17-Aug | 195 | 0.44 | <0.18 | NA | NA | 0.39 | 660 | 17.0 | 2.9 | 0.19 | 1.9 |
| MEAN | | | 0.77 | <0.30 | NA | NA | 0.48 | 623 | 25.2 | 3.4 | 0.24 | 1.9 |
| NE | 18-Jun | 25 | 1.13 | <0.36 | 21 | 0.23 | 0.78 | 2030 | 45.3 | 5.9 | 0.37 | 2.3 |
| | 24-Jul | 106 | 1.10 | <0.36 | NA | NA | 0.60 | 590 | 27.7 | 3.5 | 0.30 | 4.1 |
| | 17-Aug | 196 | <0.36 | <0.18 | NA | NA | 0.17 | 670 | 46.5 | 9.3 | NA | 3.4 |
| MEAN | | | <0.86 | <0.30 | NA | NA | 0.52 | 1097 | 39.8 | 6.2 | 0.34 | 3.3 |
| F | 18-Jun | 26 | 1.13 | <0.36 | 29 | 0.29 | 0.12 | 2260 | 47.5 | 5.3 | 0.53 | 3.3 |
| | 24-Jul | 105 | 1.10 | <0.36 | NA | NA | 0.46 | 870 | 83.3 | 14.4 | 0.70 | 11.1 |
| | 17-Aug | 194 | <0.36 | <0.18 | NA | NA | 0.73 | 1050 | 128.7 | 24.6 | 0.99 | 23.2 |
| MEAN | | | <0.86 | <0.30 | NA | NA | 0.44 | 1393 | 86.5 | 14.7 | 0.74 | 12.5 |
| EM | 18-Jun | 27 | 0.75 | <0.36 | 30 | 0.13 | 0.24 | 2450 | 115.5 | 7.6 | 0.48 | 3.2 |
| | 23-Jul | 101 | 0.55 | <0.36 | NA | NA | <0.03 | 1480 | 95.2 | 15.6 | 0.44 | 7.9 |
| | 17-Aug | 197 | <0.36 | <0.18 | NA | NA | 0.12 | 1030 | 244.3 | 42.5 | 0.95 | 23.8 |
| MEAN | | | <0.55 | <0.30 | NA | NA | <0.13 | 1653 | 151.7 | 21.9 | 0.62 | 11.6 |
| CM | 18-Jun | 28 | 0.75 | 0.36 | 29 | 0.23 | 0.36 | 1030 | 44.8 | 5.8 | 0.54 | 2.6 |
| | 23-Jul | 102 | 1.10 | <0.36 | NA | NA | 0.42 | 1710 | 33.7 | 5.2 | 0.55 | 3.2 |
| | 17-Aug | 198 | <0.36 | <0.18 | NA | NA | 0.84 | 990 | 58.7 | 9.3 | 0.37 | 7.3 |
| MEAN | | | <0.74 | <0.30 | NA | NA | 0.54 | 1243 | 45.7 | 6.8 | 0.49 | 4.4 |

Table 13. Cont'd.

| Location | Date | Anal# | Fe | Mn | TDN | TDP | NH4 | DOC | SC | SN | SP | Chl-a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | µm/L | | | | | µg/L |
| WM | 18-Jun | 29 | 0.75 | 0.36 | 29 | 0.35 | 0.66 | 720 | 44.0 | 5.6 | 0.54 | < 0.1 |
| | 23-Jul | 103 | 1.10 | <0.36 | NA | NA | 0.97 | 1300 | 91.5 | 15.9 | 0.86 | 9.5 |
| | 17-Aug | 199 | <0.36 | <0.18 | NA | NA | 0.46 | 1080 | 192.5 | 35.0 | 1.37 | 34.6 |
| MEAN | | | <0.74 | <0.30 | NA | NA | 0.70 | 1033 | 109.3 | 18.8 | 0.92 | <14.7 |
| I | 19-Jun | 34 | 3.01 | 0.36 | 44 | 0.77 | 0.20 | 3080 | 126.3 | 10.8 | 1.15 | 5.4 |
| | 25-Jul | 112 | 9.91 | 1.93 | NA | NA | 1.78 | 870 | 136.3 | 29.6 | 1.50 | 26.0 |
| | 18-Aug | 209 | 0.44 | <0.18 | NA | NA | 9.27 | 1340 | 53.2 | 8.2 | 0.84 | 6.8 |
| MEAN | | | 4.45 | <0.83 | NA | NA | 3.75 | 1763 | 105.3 | 16.2 | 1.16 | 12.7 |
| WB | 20-Jun | 43 | 0.75 | <0.36 | 22 | 0.16 | 0.49 | 680 | 24.5 | 2.3 | 0.28 | 1.1 |
| | 20-Jul | 92 | 1.10 | <0.36 | 21 | 0.19 | 0.50 | 600 | 39.0 | 4.9 | 0.28 | 3.1 |
| | 24-Aug | 237 | 0.88 | <0.18 | 23 | 0.29 | 0.54 | 690 | 35.3 | 4.9 | 0.21 | 2.2 |
| MEAN | | | 0.91 | <0.30 | 22 | 0.22 | 0.51 | 657 | 32.9 | 4.0 | 0.26 | 2.1 |

Table 14. Other limnological variables at 1981 sampling sites; total suspended solids (TSS), temperature (TEMP), daily primary production of carbon (PROD), molecular oxygen concentration ($O_2$ CONC), relative saturation ($O_2$ SAT) and oxygen consumption in the water column ($O_2$ RESP), and absorbances at 455 nm after centrifugation and at 543 nm before filtration (UNFILT), after filtration (FILT), and after centrifugation (CENT) at 13 sites in the area of the Churchill River diversion, 1981. The "MEAN" primary production value is the mean integral daily carbon fixed by photosynthesis over the period 19 June to 18 August inclusive (61 days). The analytical number (Anal #) is an internal reference number.

| Location | Date | Anal# | TSS mg/L | TEMP °C | PROD carbon $mg/m^{-2}d$ | $O_2$ | | | Absorbances at wavelengths | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CONC µm/L | SAT % | RESP $µm/m^{-3}hr$ | 455 nm (ABS) | 543 nm | | |
| | | | | | | | | | | UNFILT | FILT | CENT |
| G | 19-Jun | 35 | 6.1 | NA | 194 | 327 | NA | 107 | 0.034 | 0.082 | 0.022 | 0.011 |
| | 25-Jul | 111 | NA | 17.78 | 823 | 290 | 97 | 294 | 0.031 | 0.115 | 0.021 | 0.010 |
| | 18-Aug | 207 | 4.0 | 20.55 | 590 | 290 | 102 | 438 | 0.028 | 0.083 | 0.020 | 0.012 |
| MEAN | | | 5.0 | 19.17 | 587 | 302 | 100 | 280 | 0.031 | 0.093 | 0.021 | 0.011 |
| 6 | 19-Jun | 33 | 5.9 | 14.09 | 122 | 354 | 109 | 247 | 0.034 | 0.201 | 0.032 | 0.013 |
| | 25-Jul | 113 | 8.8 | 16.69 | 278 | 295 | 96 | 265 | 0.038 | 0.380 | 0.070 | 0.013 |
| | 18-Aug | 208 | 5.3 | 18.90 | 284 | 281 | 96 | 218 | 0.033 | 0.183 | 0.051 | 0.012 |
| MEAN | | | 6.7 | 16.56 | 238 | 310 | 100 | 243 | 0.035 | 0.255 | 0.051 | 0.013 |
| 4 | 19-Jun | 31 | 8.0 | 4.73 | 96 | 385 | 95 | 519 | 0.040 | 0.264 | 0.085 | 0.017 |
| | 25-Jul | 109 | 5.3 | NA | 551 | 325 | NA | 408 | 0.040 | 0.162 | 0.058 | 0.015 |
| | 18-Aug | 205 | NA | 17.36 | 228 | 303 | 100 | 290 | 0.036 | 0.177 | 0.042 | 0.015 |
| MEAN | | | 6.6 | 11.05 | 310 | 338 | 98 | 406 | 0.039 | 0.201 | 0.062 | 0.016 |
| 5 | 19-Jun | 30 | 3.2 | 7.12 | 224 | 358 | 94 | 755 | 0.072 | 0.064 | 0.036 | 0.025 |
| | 25-Jul | 108 | 3.3 | 16.55 | 499 | 304 | 99 | 219 | 0.065 | 0.110 | 0.038 | 0.022 |
| | 18-Aug | 204 | 3.1 | 17.97 | 414 | 283 | 95 | 343 | 0.062 | 0.099 | 0.028 | 0.022 |
| MEAN | | | 3.2 | 13.88 | 408 | 315 | 96 | 439 | 0.066 | 0.091 | 0.034 | 0.023 |

Table 14. Cont'd.

| Location | Date | Anal# | TSS mg/L | TEMP °C | PROD carbon $mg/m^{-2}d$ | $O_2$ CONC µm/L | $O_2$ SAT % | $O_2$ RESP $µm/m^{-3}hr$ | Absorbances at wavelengths 455 nm (ABS) | 543 nm UNFILT | 543 nm FILT | 543 nm CENT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SA | 19-Jun | 32 | 3.5 | 16.00 | 170 | 294 | 95 | 169 | 0.165 | 0.179 | 0.085 | 0.065 |
| | 25-Jul | 110 | 2.1 | NA | 866 | 289 | NA | 545 | 0.108 | 0.110 | 0.050 | 0.039 |
| | 18-Aug | 206 | 3.0 | 18.63 | 441 | 268 | 91 | 380 | 0.042 | 0.108 | 0.044 | 0.033 |
| MEAN | | | 2.9 | 17.32 | 543 | 284 | 93 | 365 | 0.105 | 0.132 | 0.060 | 0.046 |
| NW | 18-Jun | 24 | NA | 10.36 | 140 | 332 | 95 | 142 | 0.043 | 0.068 | NA | 0.021 |
| | 24-Jul | 107 | NA | 17.25 | 1177 | 275 | 91 | 267 | 0.038 | 0.075 | 0.020 | 0.010 |
| | 17-Aug | 195 | 1.7 | 18.48 | 260 | 275 | 93 | 164 | 0.040 | 0.063 | 0.025 | 0.012 |
| MEAN | | | NA | 15.36 | 734 | 294 | 93 | 191 | 0.040 | 0.069 | 0.023 | 0.014 |
| NE | 18-Jun | 25 | 3.3 | 8.74 | 199 | 344 | 95 | 354 | 0.045 | 0.127 | NA | 0.018 |
| | 24-Jul | 106 | NA | 12.15 | 534 | 278 | 82 | 252 | 0.040 | 0.092 | 0.023 | 0.012 |
| | 17-Aug | 196 | 2.1 | 18.44 | 640 | 293 | 99 | 412 | 0.035 | 0.065 | 0.015 | 0.010 |
| MEAN | | | 2.7 | 13.11 | 436 | 305 | 92 | 339 | 0.040 | 0.095 | 0.019 | 0.013 |
| F | 18-Jun | 26 | 4.6 | 13.74 | 186 | 298 | 92 | 114 | 0.070 | 0.142 | NA | 0.022 |
| | 24-Jul | 105 | NA | 17.80 | 1928 | 285 | 95 | 536 | 0.062 | 0.152 | 0.027 | 0.018 |
| | 17-Aug | 194 | 5.8 | 18.63 | 1421 | 283 | 96 | 1003 | 0.063 | 0.120 | 0.026 | 0.018 |
| MEAN | | | 5.2 | 16.72 | 1262 | 289 | 94 | 551 | 0.065 | 0.138 | 0.027 | 0.019 |
| EM | 18-Jun | 27 | 3.2 | 14.67 | 321 | 302 | 95 | 151 | 0.044 | 0.082 | NA | 0.014 |
| | 23-Jul | 101 | 4.1 | 20.50 | 1462 | 302 | 106 | 523 | 0.038 | 0.088 | 0.018 | 0.012 |
| | 17-Aug | 197 | 7.3 | 19.23 | 1682 | 303 | 104 | 1117 | 0.040 | 0.182 | 0.020 | 0.010 |
| MEAN | | | 4.9 | 18.13 | 1238 | 302 | 102 | 597 | 0.041 | 0.117 | 0.019 | 0.012 |

Table 14. Cont'd.

| Location | Date | Anal# | TSS mg/L | TEMP °C | PROD carbon $mg/m^{-2}d$ | $O_2$ | | | Absorbances at wavelengths 455 nm (ABS) | 543 nm | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CONC µm/L | SAT % | RESP $\mu m/m^{-3}hr$ | | UNFILT | FILT | CENT |
| CM | 18-Jun | 28 | 2.7 | 12.19 | 215 | 305 | 91 | 73 | 0.060 | 0.091 | NA | 0.020 |
| | 23-Jul | 102 | 1.6 | 19.06 | 281 | 284 | 97 | 247 | 0.051 | 0.060 | 0.024 | 0.016 |
| | 17-Aug | 198 | 2.9 | 18.96 | 1055 | 297 | 101 | 538 | 0.050 | 0.082 | 0.020 | 0.013 |
| MEAN | | | 2.4 | 16.74 | 415 | 295 | 96 | 286 | 0.054 | 0.078 | 0.022 | 0.016 |
| WM | 18-Jun | 29 | 2.0 | 11.34 | 171 | 251 | 73 | 122 | 0.055 | 0.059 | NA | 0.019 |
| | 23-Jul | 103 | 3.7 | 18.21 | 1340 | 266 | 90 | 468 | 0.050 | 0.097 | 0.022 | 0.018 |
| | 17-Aug | 199 | 7.7 | 19.33 | 1720 | 300 | 104 | 1295 | 0.054 | 0.175 | 0.025 | 0.014 |
| MEAN | | | 4.5 | 16.29 | 1113 | 272 | 89 | 628 | 0.053 | 0.110 | 0.024 | 0.017 |
| I | 19-Jun | 34 | 3.3 | 14.59 | 205 | 224 | 70 | NA | 0.147 | 0.144 | 0.064 | 0.053 |
| | 25-Jul | 112 | NA | 16.53 | 1523 | 248 | 81 | 727 | 0.190 | 0.178 | 0.068 | 0.062 |
| | 18-Aug | 209 | 1.7 | 19.12 | 392 | 192 | 67 | 964 | 0.178 | 0.106 | 0.068 | 0.061 |
| MEAN | | | 2.5 | 16.75 | 972 | 221 | 73 | 896 | 0.172 | 0.143 | 0.067 | 0.059 |
| WB | 20-Jun | 43 | 3.8 | 15.80 | 224 | NA | NA | NA | 0.055 | 0.123 | 0.040 | 0.021 |
| | 20-Jul | 92 | 3.5 | 18.97 | 545 | 279 | 95 | 376 | 0.040 | 0.108 | 0.030 | 0.014 |
| | 24-Aug | 237 | NA | 20.43 | 339 | 271 | 95 | 260 | 0.032 | 0.102 | 0.028 | 0.011 |
| MEAN | | | 3.6 | 18.40 | 451 | 275 | 95 | 318 | 0.042 | 0.111 | 0.033 | 0.015 |

Table 15. Concentration of total mercury ($\mu g \cdot g^{-1}$ dry weight) in various zooplankton size fractions from 13 sites in the area of the Churchill River diversion, 1981. See methods for parameter codes and sampling times.

| Site* | Z73(1) | Z73(2) | Z73(3) | MZ73 | Z153(1) | Z153(2) | Z153(3) | MZ153 | Z351(1) | Z351(2) | Z351(3) | MZ351 | Z760(1) | Z760(2) | Z760(3) | MZ760 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CM | 0.050 | 0.48 | 0.04 | 0.190 | 0.019 | 0.64 | 0.16 | 0.273 | 0.04 | 1.12 | 0.26 | 0.461 | no sample | 0.22 | no sample | 0.22 |
| EM | 0.039 | 1.65 | 0.39 | 0.693 | 0.007 | 0.86 | 0.27 | 0.374 | 0.046 | 5.00 | 1.32 | 2.122 | ——— | no sample | ——— | |
| F | 0.074 | 1.42 | no sample | 0.747 | 0.018 | 1.37 | 0.66 | 0.683 | 0.050 | 1.88 | 1.07 | 1.00 | 0.40 | 1.51 | 1.12 | 0.890 |
| G | 0.020 | 0.38 | 1.23 | 0.543 | 0.011 | no sample | 0.63 | 0.321 | 0.089 | 0.63 | 0.32 | 0.346 | no sample | no sample | <0.07 | <0.07 |
| I | 0.063 | 0.69 | 0.08 | 0.278 | 0.075 | no sample | 0.11 | 0.093 | no sample | no sample | 0.09 | 0.09 | no sample | no sample | 0.08 | 0.08 |
| WB | 0.034 | 3.45 | no sample | 1.742 | 0.009 | 3.19 | no sample | 1.600 | 0.0233 | no sample | no sample | 0.023 | ——— | no sample | ——— | |
| NE | 0.057 | 2.60 | 0.88 | 1.179 | 0.030 | 4.38 | 0.33 | 1.647 | 0.053 | 2.370 | 1.937 | 1.451 | no sample | 3.00 | no sample | 3.00 |
| NW | 0.10 | 3.20 | 0.84 | 1.38 | 0.19 | 4.56 | 1.08 | 1.943 | no sample | 3.20 | 1.67 | 2.435 | ——— | no sample | ——— | |
| 4 | 0.15 | 0.42 | 1.72 | 0.763 | no sample | 0.29 | 0.21 | 0.250 | no sample | 0.54 | 0.79 | 0.665 | ——— | no sample | ——— | |
| 5 | 0.021 | 0.72 | 0.28 | 0.340 | 0.021 | 1.66 | 0.26 | 0.647 | no sample | 1.54 | 0.46 | 1.00 | ——— | no sample | ——— | |
| SA | 0.050 | 1.24 | 0.35 | 0.547 | 0.054 | 1.96 | no sample | 1.007 | 0.007 | 0.12 | 8.74 | 2.956 | 0.009 | 0.20 | 3.24 | 1.150 |
| 6 | 0.10 | 0.69 | 0.03 | 0.273 | no sample | 2.90 | 0.03 | 1.465 | no sample | 3.93 | 0.28 | 2.105 | | no sample | | |
| WM | 0.11 | 1.41 | 0.28 | 0.60 | 0.058 | no sample | 1.19 | 0.624 | 0.021 | 2.69 | 0.40 | 1.037 | no sample | no sample | 0.20 | 0.20 |

* See Table 1 for key.

Table 16. Correlation coefficients between the mean concentrations of total mercury in yellow perch muscle (YPHG) and spottail shiner muscle (STHG) (Tables 8 and 9) and the concentration of total mercury of the upper 2 cm of unflooded soil (Table 1), of the upper horizons of unflooded soil (Table 2), and of the sediment (Table 4), the apparent depletion of total mercury in soil horizons (Tables 2 and 4), the means of various limnological parameters (Tables 12, 13, and 14), and the means of the concentrations of total mercury in various net plankton size fractions (Table 15) for 13 sites in the area of the Churchill River diversion, 1981. Number of data pairs for each correlation coefficient is shown in parentheses. See methods for parameter codes.

| | YPHG | | STHG | |
|---|---|---|---|---|
| STHG | 0.65 | (6) | - | |
| Upper 2 cm of soil Hg | -0.01 | (7) | 0.09 | (12) |
| Moss/peat/litter Hg | -0.01 | (7) | 0.09 | (12) |
| Ah Hg | 0.72 | (7) | 0.64 | (12) |
| Sediment Hg | 0.42 | (7) | -0.30 | (12) |
| Moss/peat/litter Hg depletion | 0.34 | (3) | -0.16 | ( 5) |
| Ah Hg depletion | 0.74 | (5) | 0.63 | (10) |
| Clay Hg depletion | 0.29 | (5) | 0.02 | (10) |
| Upper 2 cm of soil Hg depletion | 0.34 | (3) | -0.16 | ( 5) |
| Mean water temp | -0.58 | (7) | -0.84 | (12) |
| Mean TDN | - | | - | |
| Mean TDP | - | | - | |
| Mean TSS | 0.01 | (7) | -0.27 | (12) |
| Mean suspended P | 0.13 | (7) | -0.21 | (12) |
| Mean suspended N | 0.01 | (7) | -0.25 | (12) |
| Mean suspended C | -0.15 | (7) | -0.32 | (12) |
| M PROD | 0.11 | (7) | -0.21 | (12) |
| M DOC | -0.24 | (7) | -0.35 | (12) |
| M SAT | -0.09 | (7) | -0.35 | (12) |
| M RESP | 0.02 | (7) | -0.10 | (12) |
| M COND | 0.69 | (7) | 0 | (12) |
| M ABS | 0.05 | (7) | 0.08 | (12) |
| M ΔFILT | 0.04 | (7) | -0.19 | (12) |
| M ΔCENT | -0.16 | (7) | 0.14 | (12) |
| M Z73 | 0.03 | (7) | -0.01 | (12) |
| M Z153 | 0.57 | (7) | 0.26 | (12) |
| M Z351 | -0.03 | (7) | 0.24 | (12) |
| M Z760 | 0.87 | (5) | 0.89 | ( 6) |

Table 17. Correlation coefficients between the mean concentrations of total mercury in yellow perch muscle (YPHG) and spottail shiner muscle (STHG) (Tables 8 and 9) and the values of various limnological parameters (Tables 12, 13, and 14) and the concentration of total mercury in various net plankton size fractions (Table 15) for 13 sites in the area of the Churchill River diversion, 1981. Number of data pairs for each correlation coefficient is shown in brackets. See methods for parameter codes.

| | YPHG | STHG | | YPHG | STHG |
|---|---|---|---|---|---|
| TEMP 1 | -0.23 (6) | -0.78 (11) | SAT 1 | 0.21 (6) | 0.18 (10) |
| TEMP 2 | -0.19 (7) | -0.69 (10) | SAT 2 | -0.64 (5) | -0.45 ( 8) |
| TEMP 3 | -0.68 (7) | -0.85 (12) | SAT 3 | 0.01 (7) | -0.33 (12) |
| TDN 1 | 0.00 (7) | -0.26 (12) | RESP 1 | 0.08 (6) | 0.68 (11) |
| TDN 2 | - | - | RESP 2 | -0.03 (7) | -0.37 (12) |
| TDN 3 | - | - | RESP 3 | 0.11 (7) | -0.28 (12) |
| TDP 1 | 0.01 (7) | 0.13 (12) | COND 1 | 0.49 (7) | -0.02 (12) |
| TDP 2 | - | - | COND 2 | 0.86 (4) | 0.26 ( 9) |
| TDP 3 | - | - | COND 3 | 0.78 (7) | 0.03 (12) |
| TSS 1 | -0.13 (7) | 0.04 (11) | ABS 1 | 0.14 (7) | -0.03 (12) |
| TSS 2 | -0.68 (4) | 0.14 ( 8) | ABS 2 | 0.01 (7) | 0.09 (12) |
| TSS 3 | 0.09 (7) | -0.53 (10) | ABS 3 | 0.03 (7) | 0.37 (12) |
| SP 1 | 0.03 (7) | -0.12 (12) | ΔFILT 1 | -0.56 (3) | 0.09 ( 6) |
| SP 2 | 0.11 (7) | -0.18 (12) | ΔFILT 2 | 0.12 (7) | -0.01 (12) |
| SP 3 | 0.18 (7) | -0.20 (11) | ΔFILT 3 | -0.05 (7) | -0.26 (12) |
| SN 1 | -0.12 (7) | 0.16 (12) | ΔCENT 1 | 0.00 (3) | 0.01 ( 6) |
| SN 2 | 0.03 (7) | -0.22 (12) | ΔCENT 2 | 0.08 (7) | 0.17 (12) |
| SN 3 | 0.01 (7) | -0.30 (12) | ΔCENT 3 | -0.19 (7) | -0.04 (12) |
| SC 1 | -0.33 (7) | -0.09 (12) | Z73 (1) | 0.47 (7) | 0.35 (12) |
| SC 2 | -0.07 (7) | -0.38 (12) | Z73 (2) | 0.73 (7) | 0.15 (12) |
| SC 3 | -0.05 (7) | -0.34 (12) | Z73 (3) | -0.75 (6) | 0.19 (10) |
| PROD 1 | -0.42 (7) | -0.33 (12) | Z153 (1) | 0.04 (7) | 0.44 (10) |
| PROD 2 | 0.15 (7) | -0.09 (12) | Z153 (2) | 0.35 (4) | 0.26 (10) |
| PROD 3 | 0.24 (7) | -0.30 (12) | Z153 (3) | 0.16 (7) | 0.03 (10) |
| DOC 1 | -0.31 (7) | -0.22 (12) | Z351 (1) | -0.53 (5) | -0.01 ( 8) |
| DOC 2 | 0.14 (7) | -0.33 (12) | Z351 (2) | -0.22 (6) | -0.05 (11) |
| DOC 3 | -0.12 (7) | -0.31 (12) | Z351 (3) | 0.12 (7) | -0.07 (11) |
| | | | Z760 (1) | - | - |
| | | | Z760 (2) | - | 0.99 ( 4) |
| | | | Z760 (3) | 0.91 (4) | 0.35 ( 4) |

Table 18. Correlation coefficients between the mean concentrations of total mercury in yellow perch muscle (YPHG) and spottail shiner muscle (STHG) (Tables 10 and 11) and the concentration of total mercury in upper soil horizons of unflooded soil (Table 3), and the apparent depletion of total mercury in upper soil horizons (Tables 3 and 6) for seven sites in the area of the Churchill River diversion, 1982. Number of data pairs for each correlation coefficient is shown in brackets.

| | YPHG | STHG |
|---|---|---|
| Moss/peat/litter Hg | -0.12 (7) | -0.05 (7) |
| Ah Hg | -0.30 (7) | -0.19 (7) |
| Moss/peat/litter Hg depletion | 0.24 (5) | 0.17 (5) |
| Ah Hg depletion | 0.33 (5) | 0.48 (5) |

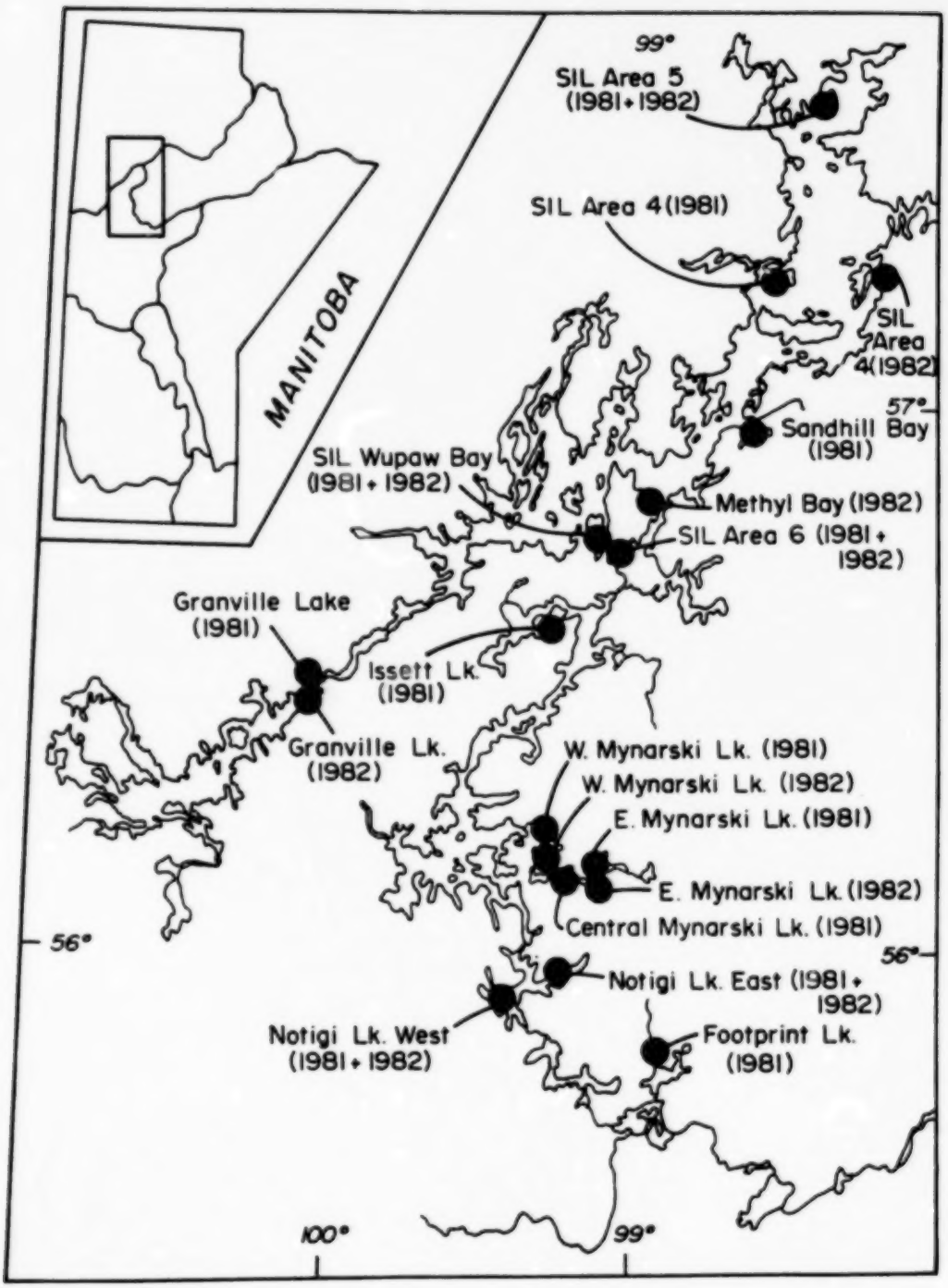


Fig. 1. Map of study area showing sample sites.